QUANTITIES OF ARSENIC AND ANTIMONY IN TOBACCO AND SMOKING CONDENSATE

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SUMMARY

Tobacco, like other plants, contains varying amounts of trace elements, depending on the soil composition, the specification of the elements, and on the characteristic absorptive properties of the plant. In tobacco, arsenic and antimony are sometimes found in higher concentrations.

During smoking volatile arsenic and antimony can be transferred from tobacco to cigarette smoke. Hence for studies and research on the transfer of these two elements by different sorts of tobacco, reliable data on the concentration levels of arsenic and antimony in soil, tobacco leaves, and cigarette smoke are of importance.

Arsenic and antimony were analysed by destructive neutron activation analysis (NAA) using rapid radiochemical separation based on extraction of their iodides. The accuracy of the results obtained was checked by the analysis of Standard Reference Materials (SRMs) and good agreement with certified values was obtained.

INTRODUCTION

In all living organisms and their processes minute quantities of some elements can play a significant biological role (1). Soil, climatic conditions, fertilizers, different agricultural sprays and the characteristic absorptive properties of the plant can influence the concentration levels of essential or toxic inorganic constituents in plant materials. Among them, tobacco holds a leading position as an article of human consumption and is one of the most frequently used plant in the study of mineral composition and nutrition (2).

Investigations of the arsenic content in tobacco has a long history, but for antimony data are very scarce. Until recently both elements were

considered as toxic, but new literature data show evidence for the essentiality of As, while for Sb its beneficial or toxic effects for living organisms are still in the phase of extensive investigation (1).

Both elements are included in the group of elements which can be partly volatilized in the smoke and inhaled, and so are of prime interest in studies of pulmonary absorption in man. Thus the purpose of our work is to present reliable quantitative data on concentration levels of As and Sb in different sorts of domestic and foreign tobaccos, filter butts and tar after smoking of an appropriate number of cigarettes with a mechanical smoker. The results were obtained by the use of NAA with a rapid radiochemical separation developed and tested previously in our laboratory (3-6).

EXPERIMENTAL

1. Irradiation: Neutron irradiation of lyophilized samples and appropriate standards was performed in our TRIGA MARK II REACTOR for about 20 hours in the rotatory specimen rack at a neutron flux of 2×10^{12} $n.cm^{-2}.s^{-1}$.

2. Radiochemical separation: Briefly the radiochemical separation is based on wet destruction of the samples (200-300 mg; $H_2SO_4 + HNO_3 + H_2O_2$), on subsequent extraction of AsI_3 and SbI_3 in toluene and on selective stripping of antimony from the organic phase with a mixture of 6 M HCl/ 0.5 M KI.

3. Measurement of γ-activity: Measurements of the γ-activity of the organic phase for ^{76}As ($T_{1/2}$= 26.4 h; E_γ = 0.559 MeV) and the HCl/KI phase for ^{122}Sb ($T_{1/2}$= 2.7 d; E_γ= 0.560 MeV) were performed with a "3x3" NaI/Tl "well type" detector, or with planar and "well type" HP Ge detectors connected to a multichannel analyser.

4. Chemical yields were shown by tracer experiments to be quantitative.

RESULTS AND DISCUSSION

Arsenic and antimony are volatile elements at high temperature and so can be partly absorbed through the pulmonary system during smoking into blood, liver, lung and especially kidney. Hence knowledge of the concentration

levels of these two elements in tobacco leaves and not least also in cigarette smoke and its condensate is very important for studies connected with pulmonary absorption and the health effects of volatile elements (toxic or essential) on living organisms. It is also relevant to aspects of the uptake of trace elements by plants.

In collaboration with the Tobacco Factory from Rovinj some types of Burley tobacco cultivated in the Istrian peninsula were analysed for As and Sb, and the results obtained were compared with the values for Burley and other sorts of tobaccos from different geographical regions (Table 1).

From the data for As and Sb in common Burley, Prilep and Virginia tobaccos from different regions it is evident that the concentration levels for these elements are practically the same. In comparison with our previous results (7) the concentration levels for As and Sb decrease because of the decreasing use of As-containing herbicides in the protection of tobacco plants. In cultivated Istrian Burley treated with As and Se, the results for As obtained show differences in concentration levels between lower, middle, and upper leaves and their veins which depend on the sort of tobacco and strongly on the soil texture and its iron and phosphorus content. The preliminary results for these two elements in filter butts and tar after smoking show rather low values and this suggests that the transfer of these two elements into smoke condensate and further into human body is small, though their amounts in smoke need investigation.

Analyses of shredded noncertified reference Kentucky Tobacco 2R-I and two candidate tobacco materials (CTA-OTL-1, CTA-VTL-2), prepared by the Polish Academy of Science were also performed.

The accuracy of results obtained was checked by the analysis of different SRMs and good agreement with certified values was obtained; this proved the reliability of the radiochemical separation procedure for determination of As and Sb in biological materials developed previously in our department.

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Table I: Results for As and Sb in various tobaccos, filter butts, tar and standard reference materials (µg kg^{-1} dry weight)

Type of tobacco and other samples	Locality	Position of leaves	As	Sb
PRILEP	Bitola (Yu)		550	49
	Pirot (Yu)		590	145
	Radovište (Yu)		540	46
	Strumica (Yu)		430	54
VIRGINIA	Orašje (Yu)		310	58
	Podravska Slatina (Yu)		300	51
	Virovitica (Yu)		130	20
	Zimbabwe		70 - 100	8 - 17
BURLEY	Orašje (Yu)		460	31
	Paraguay		320	22
	Virovitica (Yu)		230	49
	Zrenjanin (Yu)		440	75
ISTRIAN BURLEY	Valtinijana (Yu)	bottom	160	39
sort: Čulinec		middle	410	62
		upper	560	61
untreated		vein	340	31
	soil		17000	690
ISTRIAN BURLEY	Valtinijana (Yu)	bottom	2400	166
sort: Čulinec		middle	420	77
		upper	520	125
treated with As and Se		vein	193	10
ISTRIAN BURLEY	Sosići (Yu)	bottom	5040	80
sort: American B 21		middle	1240	70
		upper	490	99
treated with As and Se		vein	430	20
	soil		20000	680
KENTUCKY TOBACCO 2 RI			505 ± 66 (n = 6)	63 ± 10 (n = 6)
CTA-OTL-1* Oriental Tobacco Leaves			432 ± 75 (n = 4)	45 ± 7 (n = 4)
CTA-VTL-2* Virginia Tobacco Leaves			897 ± 57 (n = 4)	270 ± 45 (n = 4)
Filter butts µg/kg of Burley Tobacco			30 - 70 (n = 8)	9 - 15 (n = 8)
Tar µg/kg of Burley Tobacco			2 - 12 (n = 12)	0.5 - 5 (n = 12)
NBS SRM 1577 A (8) New Bovine Liver			56 ± 3 (n = 6) c.v. 47 ± 6	31 ± 0.1 (n = 5) (30)
NBS SRM 1572 Citrus Leaves			3380 ± 50 (n = 6) c.v. 3100 ± 300	34 ± 1 (n = 6) 40 ± 10

c.v. = certified value
n = number of determinations
* = Candidate reference materials from the Polish Academy of Science, Warsaw.

2023118386